The future of work in the digital transformation

Board of Academic Advisors at the Federal Ministry for Economic Affairs and Climate Action (Wissenschaftlicher Beirat beim Bundesministerium für Wirtschaft und Klimaschutz, BMWK)

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At several meetings, most recently on 10 February 2022, the Board of Academic Advisors at the Federal Ministry for Economic Affairs and Climate Action dealt with the topic of

"The future of work in the digital transformation"

and arrived at the following statement:

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I. Introduction

In the German government's coalition agreement, the word "transformation" is a key term that appears 42 times in different contexts. The transformation of the economy in the face of numerous challenges is undoubtedly necessary. However, it also raises fears of painful changes, unemployment, loss of status and the devaluation of individual qualifications. In this report, the Board looks at the upheavals to be expected as a result of the **digital transformation,** its impact on the future of work, and how the state can respond to the anticipated challenges. Warnings of **technologically induced mass unemployment** run through history (see Mokyr et al. 2015) and can already be found in the work of Aristotle (384–322 BC). So far, these prophecies have never come true in the long run. True, there has been a permanent **substitution of human labour by capital.** Entire professions have disappeared over time, and activities formerly performed by humans have been replaced by machines. However, complementary to the new technologies, **new professions** have emerged again and again. Aggregate labour demand has not shown a technologically induced downward trend. Rather, the rise in labour productivity has translated into **long-term increases in real wages and living standards.**

In the short term, however, new technologies, such as the increased use of industrial robots in manufacturing since the 1990s, can certainly lead to painful **structural disruptions** in the labour market (cf. Acemoglu/Restrepo 2018, 2020). Compared to other countries, Germany has so far succeeded well in cushioning these disruptions or preventing them from occurring in the first place. For example, Dauth et al. (2021) show that robot use has not led to an increase in individual unemployment risk for industrial workers. The adaptability of employees and their interest groups as well as the flexibility of companies contributed to this. **In-company training** successfully responded to radically changed requirements, thereby helping to secure jobs and

specific human capital. Likewise, the strong global market position of German industry helped translate productivity gains into increasing world market shares, which ultimately stabilised domestic industrial employment and wage levels. However, these are not automatisms that must inevitably be repeated. Future developments in the field of digital technologies, such as **artificial intelligence,** may have more profound and **problematic labour market effects.** For example, occupations and industries could be affected, particularly in the service sector, where in-house solutions in the interests of employees are more difficult to implement. In addition, Germany does not act as a global industry leader in these technologies, but lags behind the world leaders in some cases. Consequently, further developments in these technologies could be accompanied by a loss of market share and corresponding adverse effects on the labour market. In the view of the Board, there is no reason to worry about technology-induced mass unemployment in Germany. The **demographic development** taking place at the same time speaks against this. The retirement of the baby boomer generation will lead to a labour market exit of around 5.2 million qualified employees by 2030. At the same time, only around 3.9 million new entrants to the labour market are currently expected. This is likely to lead to an enormous **shortage of skilled workers** in many areas of the economy – in other words, precisely the opposite of mass technological unemployment (Varian 2020).

At the same time, the digital transformation may lead to an intensified **mismatch** between the skill profiles on offer and those in demand on the labour market. Jobs may be lost if activities previously performed by people are now performed using new technologies. If the skill profiles of those affected are not a perfect match for the vacant or newly-created jobs in other segments of the labour market, which may be located elsewhere in Germany, a **coexistence of skills shortages and unemployment**

is possible, which can at best be resolved in the medium term.

In addition, the digital transformation may lead to a **worsening of inequality** in the area of wage and income distribution. Such effects were already visible in Germany in the course of the robotisation of industry, although not particularly strong in quantitative terms (Dauth et al. 2021). These distribution effects could accelerate accordingly with the new digital technologies and lead to additional burdens in the social security systems.

The labour market and distribution effects of digital transformation thus pose potentially major challenges for economic policy. The German government should address these challenges proactively and take the appropriate steps. To this end, the Board draws up concrete economic policy recommendations and considerations of the perspectives in **three central areas of action** in this report:

- a **digital catching-up process** to strengthen the market position of German companies,
- a comprehensive strategy for strengthening **education and training** and integrating them into everyday working life,
- the design of tax and economic policies for productive employment and against rising inequality.

Section II first provides a classification as well as a brief overview of the labour market effects of previous episodes of the digital transformation. Section III characterises the properties of currently early-stage technologies that are likely to be more widely deployed in the future and discusses their distributional effects and potential impact on the labour market. Section IV is devoted to the Board's recommendations for economic policy action, and section V summarises them in condensed form.

II. Labour market effects of digital transformation processes to date

II.1 Review and classification

Technical progress has not just been around since digitalisation, and it has always had an impact on the labour market. The **heterogeneous mechanisms of digital transformation will also lead to massive change** and make certain human activities or professions superfluous.

Some of the change has already taken place: at airports, for example, facial recognition software largely takes over border control, and on motorways, electronic guidance systems control traffic. Workers for these tasks are no longer needed. Other facets of change are not yet complete, but are likely in the foreseeable future. For example, software can scan medical imaging results for signs of disease. Courts can use offender profiles to predict whether defendants will reoffend. Instead of offering an introduction to statistics at many universities, students can be directed to introductory videos. Still other facets are on a more distant horizon, such as self-driving cars or 3D printing of entire homes. In the **long run,** this too could **reduce the demand for certain professions** (such as cab drivers or bricklayers).[1]

The fact that there will soon be less demand for certain human occupations as a result of new digital technologies is reflected in quantifications of the **substitution potential** (Frey and Osborne 2017; Arntz et al. 2017). Based on expert estimates, this indicates which occupations could be fully or partially automated according to the current state of the art. However, the decision as to whether (partial) automation actually takes place is **not purely technically determined.** Rather, the choice of factor

input in production is an economic decision that companies make in view of current and expected prices in competition. Not everything that could be automated is actually automated – at least not completely and immediately. Moreover, the number of occupations and their specific job profiles are not fixed, but also change with technology.

So far, no significant correlation between the measured substitution potential and the actual subsequent employment growth of the respective occupational field can be identified in Germany (Dengler and Matthes 2018). One reason is likely to be that technological developments not only lead to the displacement of human labour, but also to the **adaptation of activity profiles,** the further **development of business models** and the **development of new occupations.** As a result of the partial automation of some aspects of their jobs, employees gain time for other activities (that are more difficult to automate) – for example, doctors spend less time analysing x-rays and more time communicating with their patients. In short, new technologies lead to **displacement** on the one hand, but also create new and **complementary** forms of **work.** Which effect will ultimately prevail is a priori unclear and depends heavily on the specifics of the respective job description. It has always been the case that occupations disappear completely in the course of transformation. Nevertheless, Germany has not run out of work overall. Is the change triggered by digitalisation qualitatively different or quantitatively more significant than earlier developments? To answer this question, we first look at the labour market effects of digital technologies, which have already been in use for several years.

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1   In open economies, there are further displacement effects, as the importance of local proximity decreases in a networked environment. In the past, for example, many publishers employed in-house editors, but now many have their editing work done in Asia. This does not mean that the total amount of work is decreasing, but it has been shifted to a different location in the course of the digital transformation.

II.2 Labour market effects of industrial robots in Germany

The current labour market literature primarily examines the effects of "routine-based" technological change, in which manual and cognitive routine activities are substituted by information technologies (e.g. Acemoglu and Autor 2011). Recent empirical studies examine the **labour market effects of industrial robots** as one aspect of the digital transformation. This technology has existed sufficiently long to enable an evidence-based research approach to be taken. For the U.S., Acemoglu and Restrepo (2018, 2020) show a significant negative impact on total employment in the U.S. labour market. According to them, each installed robot reduced total employment in the U.S. by about six jobs and exacerbated income inequality.

For the German labour market, the picture is friendlier. Dauth et al. (2021) attest to a long-term decline of only two jobs per robot in the manufacturing sector. This was offset by gains of the same magnitude in other sectors (especially business-related services), so that the **aggregate employment effect of robotisation is zero.** Moreover, the structural change did **not occur disruptively through layoffs** of industrial employees. They were not individually exposed to a higher risk of redeployment or even unemployment as a result of robotisation. Rather, the decline in industrial employment resulted from the fact that vacant positions were not refilled, for example, when employees reached retirement age. Young cohorts thus experienced changing patterns of career entry. Over time, there were fewer and fewer career starts in industry. Instead, more and more career starters began their working lives in the service sector, which is mostly closely related to industry, and this was achieved at comparable starting wages. In anticipation of this structural change, young cohorts adjusted their educational

decisions and tended to invest more in their human capital already during the (higher) education stage in more robotised regions.

Two reasons seem to be decisive for why robotisation in Germany – unlike in other countries – has not led so much to disruptive individual job losses among industrial employees. First, German labour market institutions favour the **retention of firm-specific human capital.** For example, Dauth et al. (2021) show that robotisation has led to major changes in job profiles in otherwise stable jobs. Thus, firms have largely met their changed labour demand by retraining and upgrading their core staff accordingly, which has tended to be accompanied by a move up the occupational hierarchy for those affected (so-called skill upgrading). These in-company solutions tended to be more pronounced in regions with a higher degree of unionisation. This is indicative of the **contribution of works councils to safeguarding employment.** In return, employees were willing to accept moderate wage agreements below real productivity growth.

Second, the relatively positive employment effects in Germany may be due to the fact that many domestic industrial companies had a **status as global industry leaders,** for example in the highly robotised automotive industry. For example, Smolka et al. (2021) show that new digital technologies (including industrial robotics) are used more in productive companies with high market shares. These companies then tend to be able to expand their productivity, market position and employment through the increased use of technology, while negative employment effects are concentrated in those companies that do not use the corresponding technologies at all or use them to a much lesser extent. Stiebale et al. (2020) document a similar pattern in the manufacturing sector in six European countries.

Thus, the increased use of robots may have had negative employment effects in countries with relatively unproductive firms (cf. Faber 2020), but not in Germany.

Nevertheless, some **distributional effects** in companies have also become apparent in Germany in response to the use of industrial robotics (Dauth et al. 2021). There were disproportionate income gains for capital owners and for highly qualified employees, especially in technical professions and in management. Skilled workers in the middle wage segment, on the other hand, tended to suffer losses, partly as part of a compromise to safeguard employment. Particularly negative wage effects were evident where internal company solutions failed and a job change became necessary. So far, however, these distribution effects have been relatively weak in quantitative terms.

III. The coming waves of digital transformation

Industrial robotics is an established technology that has been in use for decades. In contrast, a comparable evidence-based approach to identifying labour market effects is currently not available for the latest digital technologies, such as artificial intelligence (AI). While there are first relevant studies (Acemoglu et al. 2021), mainly **company surveys** on planned employment changes are currently used (e. g., Arntz et al. 2019; WEF 2020). Forecasts on this basis are subject to a **much higher degree of uncertainty,** but allow certain conclusions to be drawn about expected labour market trends.

In this section, we first describe some characteristics of digital technologies (III.1.) and discuss in general terms the ways in which computers and their networking can replace or supplement human labour and what comparative advantages human labour will still have in the future (III.2.). From this, we derive some basic considerations on the possible labour market effects of the digital transformation (III.3.), focusing in particular on the problem area of skill and regional mismatches in the labour market (III.4.). We then discuss the recent literature on the distributional effects of technological change and categorise the proposals for economic policy strategies to counter rising inequality (III.5.).

III.1 Characteristics of new digital technologies

In recent decades, the technological potential of digitalisation has grown by leaps and bounds (Knieps 2021). Computers can be used for almost any purpose, are highly capable of development and can trigger innovation thrusts in many areas of life and the economy. The theory of endogenous growth therefore speaks of a **general-purpose technology (GPT),** comparable to the steam engine or electricity.

The shift from analogue to digital technology started with the invention of bipolar transistors at Bell Laboratories in 1947. Intel made home computers possible with its microprocessors in 1974. The more densely transistors could be packed onto a chip, the more applications were developed (Bresnahan and Trajtenberg 1995). The next development push came from **networking.** Not only was it possible to bundle the computing power of many computers; there was also the advantage that a specialised network was no longer needed for individual applications. With the help of an Internet connection, it is not only possible to talk to each other at a distance, as with the telephone, but also to send e-mails, hold video conferences, regulate room temperature remotely, and so on.

This general technical basis thus offers scope for **specialised solutions with enormous economic potential,** but also dangers. For example, it is possible to prioritise certain traffic (such as movies) in the network in order to minimise disruptive delays. However, if the network is overloaded by too many parallel accesses, the transmission speed is reduced. In the case of movies, this merely leads to lower consumer satisfaction. Increasingly, however, applications are being networked whose disruption would have more serious consequences. For example, a "smart grid" can better distribute peak loads in the power supply, but if the information about the current demand for electricity arrives too late, the entire network collapses. In automated driving, grid malfunctions can even be fatal.

For this **"Internet of Things", 5G networks** will not only create far stronger transmission capacity. Through a combination of cloud computing, camera-based sensors, satellite-based positioning and real-time-based communication, a dense security network will also be established for the functioning of the services (Knieps 2021).

In the field of **artificial intelligence (AI),** a central pillar of the digital transformation, **different groups of systems** can be distinguished. AI enables – for example in image and speech recognition or in systems to support autonomous driving – the construction of very powerful systems based on large amounts of data for training the systems and powerful cloud infrastructures for their provision. However, more recent research approaches are moving away from the "data-hungry" AI that has been in the foreground to date to hybrid forms in which, among other things, reducing the amount of data required for learning is central, for example in the area of human-machine interaction (HMI, cf. section IV.1).

III.2 Humans versus machines – distribution of comparative advantages

Digitalisation is helping many people to do their work better. The computer has become an indispensable part of everyday life, and hardly anyone wants to go back to the typewriter. Digitalisation is leading to **higher productivity for employees** in many areas. However, one consequence of the constantly growing technical possibilities is that they can compete with human labour.

Cognitive research has analysed how people perform the tasks that networked computers are now taking away from them. Work consists of actions that are based on decisions. The most important comparative advantage of computers is their **computational power.** Computers break down every decision into a chain of yes/no decisions.

Where the speedy processing of many pieces of information in a precisely-defined manner is important, computers are far superior to humans. Meanwhile, however, computers are penetrating more and more areas that involve more than simple arithmetic operations. This technical progress is largely based on **machine learning.** Here, the computer does not draw a logical conclusion from input to the desired output. Rather, it uses large data sets to find patterns. With the help of the patterns, it predicts what development can be expected if a certain action is taken, or the computer even takes actions itself – as in securities trading, for example.[2]

People cope with their environment by **selection.** They focus their attention only on a section of the optical, visual and haptic information that constantly assails them. People are not only good at making use of their own and other people's experiences. They select between important and unimportant experiences.[3] The human brain thus copes with the abundance of experiences from the environment mainly by forgetting.[4] But meanwhile, algorithms have also learned the art of selective perception and forgetting.[5]

People can structure and solve problems in a way that they can explain and teach to others. In this way, however, most people solve only a small part of their problems. For the large remainder, they use their **intuition.**[6] In a strict sense, a computer has no intuition. But it can be programmed in such a way that it does not refuse to make any decision. The most radical solution is a random decision. But if you look more closely, the computer makes all

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2   For a comprehensible introduction, see James et al. (2021).

3   Cf. Bakos et al. (2014) for an illustrative account.

4   Cf. Schooler and Hertwig (2005).

5   This is particularly clear for one class of deep learning algorithms, the "long short-term memory" algorithms.

6   This can be shown experimentally in two main ways: the decision time is too short to consciously process the information offered; after the decision is made, the evidence is evaluated differently (so-called coherence shifts) without the subjects becoming aware of this, cf. Glöckner et al. (2010).

predictions with reservations. Probabilities are given by the programming, which finally determine the decision. This is not fundamentally different from the mechanism by means of which the human brain prevents a person from becoming numb with uncertainty.[7]

These sketchy considerations make it clear that the gap in the mechanics of decision-making between humans and computers is much smaller than one might initially think. **The comparative advantage of humans over computers consists less and less in cognitive abilities.** Rather, humans are embedded in their social context. This context influences which part of their environment they pay attention to, which normative concerns are important to them, and how they communicate their decisions.

In principle, all this is also achievable by the decisions of a computer. Nevertheless, one difference remains. In the end, every human being decides individually and for himself or herself alone. People are shaped by their genes and their past. In contrast, every computer that uses the same algorithm and the same training data and, if applicable, the same random numbers, decides in the same way. Thus, where **unpredictability** is a relevant factor, humans tend to be superior to computers. Unpredictability not only helps protect confidentiality and immunises against interference. Above all, it creates a kind of social biodiversity and keeps a stock of solutions that helps to cope with unpredictable changes.

Human intuition often works well because individual human decision-makers can draw on a **treasure trove of experience.** This data is not only very extensive, but also organised in a powerful way. You can see this, for example, when a person draws an analogy to a similar decision-making problem.[8] He or she is aware that the analogy may be inaccurate. But it gives a good starting point for the assessment. Experience provides human decision-makers with good starting values. In the longer term, computers could take over such tasks. Networked computers can be programmed to learn from feedback about previous decisions. In the shorter term, however, this is a **comparative advantage of human decision-makers.**[9]

Humans can be inattentive, clumsy, untalented or unfair. A computer never overlooks anything, it is as skilful and talented as it has been programmed to be, and only unfair if this has been built into the program. But mankind has thousands of years of experience with human inadequacy. That is why people are experts in dealing with it.[10] This difference is one explanation for the widespread aversion to delegating decisions to computers.[11] **Many people find it easier to trust another person than a machine.** The opposite is even more important: people are confident in their judgment as to whom they should not trust. For the time being, however, this ability is mostly lacking when dealing with computers.

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7   In the process of processing, the brain changes the representation of the information until a coherent picture emerges, cf. Holyoak and Simon (1999). Cognitive science models the mental process as "parallel constraint satisfaction," openly borrowing concepts from computer science (Yokoo and Hirayama, 2000).

8   Cf. Gentner et al. (2001).

9   That is why autonomous driving is easier to implement under the standardised conditions of a motorway than in city traffic, where a child may jump into the road, an animal may cross, or a bicycle may go out of its lane. The more idiosyncratic experiences have to be in order to be good experiences, the longer humans will outperform algorithms.

10   This is impressively demonstrated by a well-known paradigm of psychological research into decision-making, known as the Wason selection task. When subjects are presented with the decision-making problem in neutral terms, most of them fail. If, on the other hand, they are told to be careful to detect any cheating, the vast majority find the correct solution, see Cosmides (1989).

11   Cf. Dietvorst et al. (2015).

The complete delegation of decisions to algorithms is therefore the exception. More often, humans receive **support from the computer,** but continue to bear the responsibility for the decision.[12] Whether such human-machine interactions are preferable to purely human decision-making depends not only on the performance of the computer. It also depends on how humans process the computer's decision-making contribution.[13] Moreover, decisions should not only be objectively good, but should also appear good to their addressees. It is often important that the addressees accept a decision, understand it and implement it in the right spirit. This is easier if it is clear why a certain decision has been taken. With human decision-makers, who must provide a **comprehensible justification,** this is an everyday occurrence.[14] In contrast, particularly accurate "deep learning" algorithms are often particularly inaccessible.[15] For the time being, there is still a comparative advantage of human decisions and work.

III.3 Possible labour market effects of the digital transformation

The preceding discussion on comparative advantages is reflected in the projections on the expected impact of the digital transformation on the world of work. A number of extensive **company surveys** have been conducted (e. g., the Future of Jobs Report of the World Economic Forum, cf. WEF 2020), in which managers were asked to indicate a) which technologies they intend to introduce or expand in their company in the coming years, and b) what

repercussions this could have for employment, i. e., what types of occupations will be reduced or expanded as a result and to what extent. Since these surveys are about future-oriented economic plans and not about realised decisions, the results of such studies must naturally be viewed with a certain degree of caution. Nevertheless, they provide a picture that is quite consistent with the evidence-based labour market literature on past transformation episodes.

Three **central findings** emerge. First, when it comes to specifying the technologies that will be important in the future, there is a great deal of agreement with the developments discussed in section III.1. According to WEF (2020), more than 70 percent of the companies surveyed state that they will increasingly rely on machine learning, big data analytics and the Internet of things in the future.

Second, it can be expected that this will lead to a **reduction in jobs,** especially in those occupations whose job profile consists to a large extent of (manual or cognitive) **routine activities.** Examples include clerks, truck drivers and lawyers. This pattern is consistent with studies on the technological substitution potential of occupations (Frey and Osborne 2017; Arntz et al. 2017) and the extensive literature on technologically induced labour market polarisation (Acemoglu and Autor 2011; Autor et al. 2020; Spitz-Oener 2006). The latter also concludes that digital technologies cause a so-called "routine-biased technological change." According to this, employees who primarily perform creative and/or non-standardised processes at their work-

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12   One example is application processes. The HR department has the computer screen and pre-classify the applications. Whether an applicant is then invited to an interview, however, is decided by the respective personnel officer.

13   Initial results in this very current field of research suggest that human decision-makers are not very good at distinguishing helpful from unsuitable contributions by computers (see Engel and Grgic-Hlaca 2021). In this case, it may well be right to leave the decision entirely to humans.

14   Cf. Engel (2007) on the intertwined behavioural effects of explicit justification.

15   Computer science has identified the lack of trust of humans in automated decisions as a weakness. Under the label "explainable AI", active research is being conducted to retroactively name the elements of the data set that supported the assessment, cf. Samek et al. (2019) and Rabold et al. (2020).

place are less at risk of substitution. These may be certain highly qualified people, but also workers without formal training, as long as they are typically confronted with different situations in their everyday work that do not follow a routine that is easy to automate. In contrast, there is a high substitution potential in occupations with a high degree of routine, which are often located in the middle of the qualification and wage spectrum.

Specifically, the company surveys anticipate an **increase in jobs** as a result of the digital transformation in occupational fields that are directly related to the development and application of the respective technologies (such as programmers or data analysis specialists). An expansion is also expected in completely different occupations in which a high level of **social and communication skills** is required (for example, in the area of customer care or in the healthcare sector), i.e., where a comparative advantage of human labour over machines is likely to continue to exist.

The third key result relates to the **overall quantitative extent** of the increase or decrease in employment. The typical picture that emerges in the projections assumes an overall neutral or even slightly positive employment effect. According to this projection, the number of jobs lost is at least compensated for by newly created jobs, albeit with completely different characteristics. However, this projection could turn out to be too optimistic, as large companies with high technology input are often overrepresented in the surveys. However, job losses occur in particular in smaller companies that do not use new digital technologies to the same extent and consequently lose market share (Smolka et al. 2021). In addition, indirect effects due to price and income changes are not taken into account.

Early **evidence-based studies on the labour market effects of AI** come to more cautious conclusions. For example, Acemoglu et al. (2021) show that the rapid expansion of AI in U.S. companies during the 2014–2018 timeframe led to a large increase in AI-related job postings, but not in total job postings or employment.

It is currently too early for a robust empirical finding on the employment effects of AI and other new digital technologies, as they are not yet being deployed on the necessary scale. However, there are many indications that the central challenge is **not likely to be a negative aggregate employment effect** or even mass technological unemployment. Rather, two problems could arise in the course of the further digital transformation, which we discuss in more detail below:

1. mismatch on the labour market, i.e. a mismatch between the skills profiles on offer and those in demand, cf. section III.4.
2. Rising wage and income inequality, see section III.5.

III.4 Qualificational and regional mismatch

Mismatch refers to a situation in which the structural characteristics of labour supply and labour demand do not match, resulting in a **temporally persistent coexistence of unemployment and job vacancies.** Such a constellation is certainly emerging in the course of the digital transformation, when – as described above – there is a reduction in jobs with a high standardisation and routine content coupled with a simultaneous increase in labour demand in completely different market segments (e.g., jobs with a high ICT or AI content). In the short term, this mismatch cannot be resolved by the price mechanism, as the redundant workers

cannot fill the parallel existing vacancies due to mismatched skill profiles. Thus, **disruptive individual job losses** can occur, which in the worst case lead to long-term unemployment or involuntary exit from the labour force.

In the long run, this mismatch dissipates, e. g., through adjustments in the skill and training decisions of the younger generation entering the labour market over time. But even in the short term, there are countervailing forces. In the past, for example, Germany in particular has succeeded well in countering the skills mismatch that has arisen in the wake of the introduction of new technologies through intensive efforts in the area of further **training and retraining** of the workforce (see section II.2.). **Demographic developments** could provide additional incentives for companies to push ahead with this "ret(r)aining" of core personnel, as recruiting new skilled workers could prove increasingly difficult. However, this strategy, which relies on job stability, reaches its limits where companies exit the market in the course of the digital transformation. For this reason, the Board recommends in section IV.2. a cross-company system of vocational training and continuing education as a central building block for further dealing with the digital transformation.

One particular problem of mismatch concerns the **regional dimension.** In an international comparison, regional differences in wage and income levels are still relatively moderate in Germany, at least within western Germany (see Südekum 2021). However, the **economic urban-rural divide** has also increased noticeably in Germany over the past 30 years (cf. Dauth et al. 2022). This trend, which has had significant political implications in other countries (cf. Rodriguez-Pose 2018), could be further exacerbated by the digital transformation. Thus, it is quite possible that the jobs that will be eliminated and the new jobs that will be created as a result of the

transformation will be found in different local labour markets. Firgo et al. (2019) show for the example of Austria that digitalisation tends to favour the creation of urban jobs, while the category of substitutable (and thus more threatened) jobs tends to be overrepresented in regions away from metropolitan areas. The OECD (2018) finds a similar geographical pattern for other countries as well. Regional migration serves as an equalizing mechanism only to a limited extent, as the process is selective in terms of age and skill level. For example, mobility is likely to tend to be weaker among the group of people presumed to face the greatest problems in the labour market as a result of digitalisation, while the mobility of young high-skilled workers to metropolitan areas tends to exacerbate rather than compensate for the urban-rural divide. This regional dimension must therefore be taken into account when designing the integrated system of education and training by supplementing it with targeted **structural and regional policy stimuli** (see section IV.2.).

III.5 Distribution effects of the digital transformation

Technological change in recent decades has been identified as a **cause of increasing income inequality.** While high-skilled workers have benefited, low-skilled workers have been increasingly affected by small income increases or even reductions. These effects have been documented in particular for the U.S., see for instance Goldin and Katz (2008), Acemoglu and Autor (2011), or Ales et al. (2015). The increased use of artificial intelligence also raises the question of whether a similar development can be expected in the future in the area of high-skilled work and could, for example, affect employees of banks or insurance companies whose professional activities are characterised by a high degree of routine. Against this background, the

current academic literature discusses tax policy instruments and the strengthening of so-called "good jobs" as possible options for action against rising inequality.

III.5.1. Tax policy instruments

A current development uses approaches from **optimal tax theory** to examine whether instruments of taxation can be used to slow down the use of robots and other forms of automation. A related question is whether the direction of technological progress, for example towards the greater use of artificial intelligence, requires government correction because of its distributional effects. To what extent are these processes drivers of inequality that should be corrected not only in retrospect through redistributive tax policy, but also as they emerge?

On the labour market, the demand of companies for employees with certain qualifications meets a heterogeneous labour supply. If there is a change in the qualification structure of the labour supply, for example because more highly educated people enter the labour market, this has an impact on the distribution of labour income. For example, if there are more highly qualified people, this reduces their wages and leads firms to expand the employment of highly qualified people overall. This subsequently increases the productivity of the low-skilled, provided there are **complementarities** between the different types of work. Stiglitz (1982) shows that an optimally redistributive tax system takes advantage of this mechanism. It creates incentives to increase the supply of high-skilled labour in order to improve the position of the low-skilled.

The work on optimal taxation of robots – see Costinaut and Werning (2020), Guerreiro et. al (2020), Löbbing (2020) or Thümmel (2020) – is based on the observation that the **productivity of high-skilled workers increases more than the productivity of low-skilled workers,** a development called "skill biased technical change". Optimally redistributive tax policies aim to curb the use of this technology because it increases labour income inequality. A conflict arises between efficiency goals and distributional goals. The desire to reduce inequality is offset by the fact that higher productivity allows goods and services to be produced with less labour input. The extent to which the use of technologies with a skill bias should be curbed therefore depends on a value judgment, namely the **weight given to the distributional objective.** The higher the inequality aversion, the higher the tax on the use of robots.[16]

Such a policy, aimed at controlling the use of technology in firms, is at odds with the idea that the state should first allow market forces to operate and then correct the market incomes generated through the tax and transfer system. The principle of **preserving efficiency in production – see Diamond and Mirrlees (1971) – is thus violated.** Instead, firms' demand for labour and capital is corrected by policymakers.

The central message of this literature is that technological progress in the form of automation and artificial intelligence can **exacerbate existing income inequality** and that, therefore, **economic policy interventions** that aim to boost employment, wages, and productivity in the low- and middle-income sectors **may be justified.**

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16   The use of robots can also be indirectly slowed down if technical progress is endogenous, cf. Löbbing (2020).

III.5.2. Good jobs as a government task?

The focus of another current approach is that it could be the task of the state to ensure that a **sufficient number of "good jobs"** are created – jobs that offer a secure income in the middle-income range and, along with it, the opportunity for social and political participation. The starting point is the observation that the classic instruments of the welfare state – namely predistribution, improving opportunities to earn income through a public education system on the one hand, and redistribution of the income earned through a progressive tax and transfer system on the other – have not been able to limit the expansion of precarious employment. Moreover, professions with high routine salaries, which are coming under particular pressure from the digital transformation, are overrepresented in the middle-income segment, so that **strong fears of relegation** can spread among the **middle class.** This has been vividly described in widely acclaimed reports that highlight the decline of the American middle class and identify it as a source of increasing political polarisation (Packer 2013; Hochschild 2016; Vance 2017). Eribon (2016) documents comparable developments in France.

According to Blanchard and Rodrik (2021, chapter 1) and Rodrik and Stantcheva (2021a,b,c), economic policies can be distinguished along two dimensions: first, in terms of whether they are upstream or downstream of the production process or affect it directly, and second, whether they primarily affect low-income, middle-income or high-income earners. State education policy, for example, is upstream of the production process, while tax policy is downstream. In addition to these classic welfare state-oriented policy areas, there is also direct political influence on production, employment and wages, for example through structural policy, support for small and medium-sized enterprises or minimum wage legislation.

Against this background, it is argued that a special task of the state is to ensure the emergence of a sufficiently large number of jobs that guarantee a medium standard of living and offer security, social participation and opportunities for advancement (Rodrik and Sabel 2021; Rodrik and Stantcheva 2021a,b,c). **Market failures** are said to occur when such jobs do not emerge in sufficient numbers (Rodrik and Sabel 2021). However, many of the policy recommendations listed in this framework for securing employment and promoting start-ups (Rodrik and Stantcheva 2021 a,b,c) have already been implemented in Germany, for example in education, labour market or regional policies. Other aspects are worthy of discussion and are dealt with in greater depth in section IV.3. of this report.

A related question is how technical progress in the field of AI will affect employment. For example, it is possible to envisage **forms that save a great deal of work,** but also forms that create work, in which new areas of business are tapped, thereby creating new employment opportunities.[17] It is argued that unregulated markets currently tend to generate too much innovation of the first category (Acemoglu 2021; Acemoglu et al. 2021). The result is an undersupply of "good jobs" with correspondingly problematic social consequences. Economic policy is called upon to ensure through appropriate regulation that **innovations take on a more job-enriching character.** However, the discussion as to which specific economic policy instruments could be used to achieve this goal is still in its infancy (see section IV.3.).

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17   As an example of the first case, automated supermarket checkouts are mentioned, which save on human labour but do not necessarily improve the shopping experience from the customer's point of view. The second case would be if AI were used to expand the range of services offered by supermarkets – for example, through individualised offers and personal advice – and thus create new employment opportunities.

The fundamental question is whether an insufficient number of good jobs should be interpreted as an indication of **market failure.** Market failure is typically spoken of when competitive markets lead to inefficient outcomes. Market outcomes can then in principle be improved in such a way that there are no losers. The conceptual classification as market failure and the resulting concrete recommendations for economic policy action have not yet been sufficiently substantiated by the emerging literature on the "*good jobs economy*".

The literature on optimal taxation of robots discussed earlier suggests a different and more useful classification. It focuses on the **conflict between efficiency goals and distributional goals.** If distributional effects – in this case with respect to the middle class – are given a high weight and redistributive measures are not sufficient, this provides grounds for interventions to protect "good jobs." However, in the view of the Board, this literature does not yet yield any direct recommendations for German economic policy (see section IV.3.).

IV. Recommendations for economic policy action

In the past, the German labour market has coped well with major structural disruptions caused by new technologies (see section II.2.). However, there are fears that further digital transformation could lead to greater mismatch in the labour market, more disruptive employment effects and more problematic distribution effects. There are three reasons for this:

a. The speed of change is greater because the technologies described potentially have broader areas of application. Thus, **substitution effects** could be **more profound,** especially if technological progress is in a direction that runs counter to the described goal of promoting productive employment ("good jobs").
b. In the future, many areas of application and substitution potential will be in the service sector (e.g., banking, insurance, logistics and transport). Compared to the industrial sector, the labour factor in these sectors is less organised. The **search for in-house solutions** to safeguard employment could therefore be weaker.
c. German companies are not global industry leaders in many new digital technologies (see BMWK Beirat 2021). There is therefore a fear that the **employment-boosting effects of technology production and use could take place to a large extent outside Germany.**

Whether such pessimistic scenarios will actually materialise is not yet foreseeable today. Nevertheless, policymakers must take these dangers into account and develop proactive economic policy strategies today so that the digital transformation can lead to positive social developments across the board.

From the Board's perspective, this results in recommendations for action for economic policy in **three key areas of action:**

● strengthening the market position of German companies in the generation and use of new digital technologies (section IV.1.),
● a strategy to strengthen and integrate education and training (IV.2.),
● shaping economic policy to strengthen productive employment and thereby counter the rise in inequality (IV.3.).

IV.1 Digital catch-up in an environment of change

IV.1.1. From research excellence to welfare gains

Numerous assessments indicate that Germany is relatively well positioned in terms of research in broad areas of digital technologies, especially artificial intelligence (AI), but has not yet succeeded in translating these strengths into value creation and approaches to solving societal problems (SVR 2021; EFI 2019, 2021). Accordingly, strengthening the transfer of basic and applied research into economic and societal application rightly takes a prominent role in the coalition agreement of the new German government.

It seems urgent to continue **strengthening technology transfer institutions** and supporting entrepreneurship at universities. In addition, **venture capital should be promoted by the state to the extent necessary** to advance the transition from pilot developments to marketable systems. As in previous statements, the Board recommends strengthening the incentives of private investors in particular in order to ultimately establish a

self-sustaining venture capital sector in Germany and Europe.[18] This has been increasingly successful in the last two years (cf. EY 2022), but there is still considerable room for improvement in an international comparison.

In the field of artificial intelligence (AI), as already indicated above, a rough distinction can be made between **three groups of AI systems,** each of which places specific demands on economic policy in order to leverage their economic potential. The **promotion and regulation of these technologies** requires different approaches.

The first and classic form of AI enables the establishment of powerful systems whose provision is based on big data and cloud infrastructures. European countries, including Germany, have not yet been able to build up any particular competitive strengths in these areas.

However, Germany can very well draw on corresponding volumes of data in the area of production of goods and in the service sector. However, their **cooperative use across company boundaries** must be ensured either by merging data or by alternative technical means (e.g. federated analysis procedures in which separately stored data can be analysed jointly even without merging). Projects by the Federal Ministry for Economic Affairs and Climate Action to provide **European cloud structures such as Gaia-X** can play an important role in this regard. Here, too, it should be borne in mind that the organisation of such structures is not the core competence of ministries. The state should work here with private partners who have the necessary

project and management expertise. The need for regulation in this first group of technical solutions is considerable (cf. below).[19]

Recent research approaches are currently moving away from the hitherto dominant "data-hungry" toward **hybrid forms of AI** in which, among other things, reducing the amount of data required for learning is central. A second group of AI solutions is comparatively unspectacular and is becoming visible in the form of new software systems that incorporate (pre-trained) machine learning algorithms. For example, the processing of insurance claims automated with the help of AI is in many cases carried out via proprietary solutions based on pre-trained systems. The dependence on U.S. gatekeeper companies is significantly lower in this area than in the aforementioned area. Company-specific solutions are increasingly being brought to market by specialised providers from Europe.

In the catch-up process, **government procurement that is open to innovation** is a particularly important measure, as systems of this kind will play a major role in the digital transformation of public administration.[20]

A third group of systems involves **close interaction between humans and machines.** Relatively well researched and introduced in production processes are systems in which industrial robots "work together" with assembly personnel. In many other areas, a number of pilot projects on human-machine interaction (HMI) have already been carried out, but further research is needed before we can speak of proven models of work organisation.[21]

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18   See BMWK Beirat (1997, 2007).

19   The success of European projects is called into question when even government decision-makers in Germany prefer U.S. gatekeeper companies even when powerful systems of European provenance (e.g., from the open-source sector) are available. The competence of public administrations in assessing technical possibilities must therefore be strengthened.

20   Cf. BMWK Beirat 2021.

21   For example, behavioural economics research on the interaction of humans and machines is currently in its infancy (cf. Chugunova and Sele 2020; Engel and Grgic-Hlaca 2021); however, its understanding is of great importance for the design of such systems.

According to acatech (2016), Germany has a good starting position that should enable it to successfully participate in global developments in the field of HMI. But a **transfer gap** also occurs here. The formation of new value creation potentials based on AI and robotics requires intensive cooperation between research, industry and public institutions. The complexity of this interaction can be illustrated by the example of care robotics (see Box 1).

Box 1 – Technology development, "learning regulation" and vocational training using the example of care robotics

The use of robotics, mechatronics and information technology, in particular machine intelligence, in the field of gerontology and geriatrics as well as in preventive, outpatient and inpatient care of the elderly is often referred to as **geriatronics.** Due to increasing life expectancy, the number of elderly people is growing who, due to physical limitations, find it difficult to cope with their daily lives and are often no longer able to live in their own homes, contrary to their wishes. With the technologies now available for the first time, **intelligent robotics** can provide an important building block for individual care at home or support in appropriate care facilities. Accordingly, these systems and services represent significant **value creation potential.** Partial automation can also counteract the shortage of skilled workers, which is likely to increase in the care sector in particular.

The use of assistance robots raises a **large number of largely unresolved legal and ethical issues.** These concern not only data protection, IT security and liability law, but also the fundamental question of autonomy. Assistance robots can strengthen personal autonomy. At the same time, however, there is a risk of paternalism, the more independently the system acts and the further the sovereignty of the person concerned is restricted as a result. The explainability of machine behaviour as a basic prerequisite for human sovereignty and the satisfaction of the need for human attention are particularly important.

Ideally, **technology development,** the establishment of new training courses and the regulation of systems should be carried out with the participation of various players (care institutions, care education and training, technological research, innovation, government procurement, regulation) **in as close a cooperation as possible.** One example of this is the Geriatronics User and Research Centre at the Technical University of Munich in Garmisch-Partenkirchen.[22] In order to create defined end and handover points between research, users and regulators, work is already under way to develop reference systems and reference environments. Ultimately, evaluation systems for the certification of systems must also be provided in order to enable transparent competition between providers ("Geriatronics technical inspection and certification").

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22 Cf. https://geriatronics.mirmi.tum.de/home_de/ (last retrieved on 21 February 2022)

The challenges in developing the required professional skills (cf. section IV.2) can also be well demonstrated using nursing as an example. As a guide to the implementation of training under the Nursing Professions Act and the Nursing Professions Training and Examination Ordinance, the Federal Government provides a framework curriculum and a framework training plan. These plans have the character of recommendations for the curricula of the federal states and the internal curricula of the nursing schools. A commission was appointed in November 2018 to prepare the framework plans by the Federal Government. The framework plans developed by the commission contain concrete proposals for the content of the new vocational nursing training programmes. They will be made available free of charge to the nursing schools and the providers of practical training. The framework plans are reviewed at least every five years to ensure that they are up to date and, if necessary, adapted. The federal states can then issue a binding curriculum as a basis for the creation of the nursing schools' internal curricula, taking into account the specifications. However, the examination of the curricula then created by the nursing schools differs from state to state, due to the competence of the states in the area of education. In Bavaria, this process is handled by the districts. The nursing schools that create the corresponding curricula have them approved by the responsible district governments (e.g., the government of Upper Bavaria).

Using the example of geriatrics, the description shows that the development of new technical systems based on AI and robotics requires **close cooperation between private and public actors** in important areas. Regulation in such systems cannot be ex ante, and certainly not ex cathedra, but must be planned as **"learning regulation".** The same applies to the creation of curricula for vocational training and the creation of new courses of study at universities (cf. section IV.2).

IV.1.2. An institutional framework for the division of labour between humans and machines

Human-machine interaction (HMI) is still **insufficiently regulated.** This is not only a matter of defence (e.g., by means of data protection), but also of rewarding valuable contributions. There is a societal interest in such contributions, especially when the performance of algorithms increases non-linearly with the amount and quality of data

they can use. An illustrative example is the conversion of spoken language into written text. Spoken language is rich and heterogeneous. The algorithm must thus recognise the variants of the spoken word and distinguish them from interfering noise. An algorithm can learn from individual users. In this case, however, only these users benefit from the learning result. An algorithm learns much better and faster if access to the data of many (preferably all) users of the software is possible, so that speech comparisons can be made. This is the case with Apple's **speech recognition software.** The speech patterns are processed in the cloud and the reaction of the users to the text suggestions is logged. This allows the algorithm to improve its quality over time. Conceptually, this is about network externalities (Katz and Shapiro 1985). The good becomes more valuable the more intensively it is used. The example raises a number of competition law issues. For example, Apple "gives away" speech recognition by offering it for free, but at the same time makes it difficult for alternative offerings to use it through

technical specifications. This could constitute an abuse of its dominant position in the market for hardware and operating systems. However, the example touches on an even more fundamental institutional issue. Users of Apple's speech recognition make a valuable contribution to its improvement with every use. So far, however, there are no well-functioning mechanisms for compensating and charging for these services. Traditional contract law is overwhelmed here.

In this context, a number of examples with corresponding problem areas could be listed. Examples include the legal standards for the preparation of decision-making by algorithms[23] or the treatment of so-called "clickworkers"[24] under labour law. Many more such questions will arise in the course of the digital transformation. The Board recommends that the German government conduct this **discussion on contract and labour law** in the spirit of "learning regulation," which is essential for realizing the economic and social potential of HMI.

IV.2 An integrated system of education and training

A key element of the economic policy response to the challenges of accelerated structural change will have to be a comprehensive strategy of **continuing vocational training.** Technological change in production processes means that the demand for certain qualifications, skills and abilities in the labour market is disappearing. Employees who acquired these qualifications during their training will have

to "write off" this human capital. For the affected employees, this can mean moving into low-skilled work or leaving the labour market. Demographic trends and the shortage of skilled workers mean that new employees will be urgently needed elsewhere in the future. But in order to seize the opportunities that arise, the employees concerned must acquire the qualifications, skills and abilities they need. The goal here must be to enable people to benefit from the opportunities offered by ongoing economic structural change.

This structural change can have several causes. In the past, it was often induced by increased trade integration (globalisation). Currently, structural change plays a major role in the context of decarbonisation, i.e., the elimination of emission-intensive and the shift toward climate-neutral business models. In this report, the focus is on structural change driven by digital transformation. Regardless of the driving force, however, further training and retraining are often seen as the **best way to deal with structural change,** particularly in order to avoid the problem of mismatch in the labour market.

Depending on the quality of the respective aspects of structural change, this involves **three different types of skills to be acquired:** (1) advanced training in new skills within the existing occupation, such as the use of new software; (2) the teaching of new general skills that have uses beyond the existing occupation, such as general computer courses; or (3) retraining in new occupational fields. An important prerequisite for all three types of training is that workers are able and willing to continue

23   The following example illustrates the tension: there is software that suggests to the HR department which applicants it should invite for interview. However, the final decision is made by a personnel administrator. Let us now assume that it can be proved that the company has used certain software that discriminates against certain groups of people. Is the company then liable under the General Equal Treatment Act, even if the personnel officer acted in good faith and was not aware of the bias of the software at the time of use?

24   "Clickworkers" are active in curating data where human expertise and contextual knowledge is needed, e.g., to classify image material. Often, "clickworkers" work on different platforms and on several projects at the same time. Legally, these are individual service or work contracts. This can run counter to the social and labour law protection of the employees, but a classic employment contract would possibly also fail due to the large number of clients. This raises the question of how to structure optimal employment contracts for these new forms of employment.

learning throughout their lives in order to constantly develop their skills and abilities and adapt them to changing demand conditions.

A key finding of classical human capital theory is that the incentives to invest in the three types of training mentioned above are distributed very differently. The more specific the skills to be acquired are for use in the particular firm, the greater the firms' incentives to finance them (Becker 1964). In the case of skills that can be used particularly extensively in other companies, it is employees themselves rather than the company they have been working for that have an incentive to undertake further training. However, the extent to which employees can obtain **a strong and credible signal that they have acquired new skills** that they can send to the other side of the market also depends on the framework conditions of the market. Depending on the incentive situation, the willingness of the respective market side to finance the various types of continuing education will also vary accordingly. Thus, the respective government options and necessities for action and economic policy responses must also differ.

IV.2.1. In-company continuing education

Qualification requirements that can be acquired "on the job" within the framework of in-company training are mostly in the interest of the respective companies. Experience gained in the course of the robotisation of German industry has shown that the necessary adjustments to structural change could often be achieved by enabling employees to switch to jobs with higher qualification profiles within the respective company (Dauth et al. 2021).[25] The new activities mostly required more abstract and less routine job profiles.

In some cases, elements of **company training strategies are regulated in the relevant collective agreements.** For example, the collective bargaining parties in the metal and electrical industry in some regions have agreed to establish an individual entitlement to training measures for all employees. Based on staff appraisals that can be requested, training needs are defined that provide for the costs to be borne by the employer in the case of training for operational reasons and, in the case of training for personal reasons, for an entitlement to re-employment in a position that is at least comparable, as well as, in some cases, the possibility of part-time training.

In the case of continuing education for activities within the previous company, the need for state intervention is limited due to the interests at stake and the coordination possibilities of the collective bargaining parties. However, there is a need for **further action** on this issue in at least **two respects.** First, participation in continuing education is significantly lower in small and medium-sized enterprises (SMEs) than in larger companies. While virtually all larger companies support continuing education activities, less than half of small companies do (Autorengruppe Bildungsberichterstattung 2020). Here, many of the mechanisms mentioned do not take effect. Second, there is some evidence to suggest that the mechanisms that have been effective in German industry to date may be less effective for the future developments of digital transformation. In many heavily affected service sectors, companies often have fewer employees and the degree of organisation of employees is less pronounced, which could limit the search for in-house solutions.

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25   For general evidence on positive income and employment effects of job-related training, see for instance Leuven (2005), Bassanini et al. (2007), De Grip and Sauermann (2012), and Ruhose et al. (2019).

In order to realise the possibility of in-company continuing education across the board, policymakers could introduce a **legal right to continuing education.** A variety of options are conceivable here. For example, companies could be required to provide their employees with a catalogue of training opportunities that the company considers beneficial, from which the employees could choose. For a certain number of days per year, employees would be entitled to further training from the respective catalogue. In this way, the goal of permanently integrating all employees into lifelong learning processes could be approached, so that no one forgets how to learn. However, such regulation may also lead to inefficient continuing education activities and circumvention. In addition, it leads to a cost burden for employers. This is where the state can support small and medium-sized enterprises.

IV.2.2. National Skills Strategy

Many of the developments addressed have clearly come to the attention of policymakers in recent years. The **National Skills Strategy** adopted in 2019 is intended to bundle and further develop the efforts for continuing education and qualification of the Federal Government, states, social partners and the Federal Employment Agency, with an explicit focus on supporting SMEs (BMAS and BMBF 2019). Concrete measures have been pursued in the context of various legislative initiatives, in particular the Skills Development Opportunities Act, the Work of Tomorrow Act (Upgrading Training Assistance Act), the Act to Secure Employment and amendments to the Upgrading Training Assistance Act and the Vocational Training Act (BMAS and BMBF 2021).

In many areas, however, the National Skills Strategy remains vague. It is primarily concerned with making existing "continuing education offerings and funding opportunities ... more transparent and more accessible" (BMAS and BMBF 2019, p. 2). Accordingly, it has been noted that there is a lack of an overall concept and that the proposed measures are not sufficient (Heinrich-Böll-Stiftung and Bertelsmann-Stiftung 2020; SVR 2021, paras. 300–312).[26] The need for a more systematic approach with a **more coherent design of the continuing education system** is also highlighted in the OECD country report on continuing vocational education and training in Germany (commissioned by the BMAS and BMBF), which draws particular attention to the extremely complex governance and financial incentive structures and the markedly low participation of low-skilled people in continuing education in Germany (OECD 2021). The Board agrees that there is still a clear **need for further development and, in particular, simplification** in this area in order to increase awareness and thus take-up of continuing education funding.

IV.2.3. Continuing education as an element of active labour market policy in the case of unemployment

The greatest challenge and most important task for politics, however, is in those qualification areas in which **retraining in new occupational fields becomes necessary** due to structural change, since in this case the support incentives of the previous employers are low. In the existing system, this issue is primarily located in the support measures for continuing vocational training of the Federal Employment Agency within the framework of active labour market policy, which were expanded in certain areas in the course of the National Skills

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26   For example, the expansion of funding opportunities under the Skills Development Opportunities Act does not appear to have had a significant effect on employees' participation in continuing education measures.

Strategy (Deutscher Bundestag 2021). It is known from evaluation research that continuing education programmes for the unemployed consistently show lock-in effects in the short term due to suspended search behaviour. Moreover, whether there are positive employment and income effects in the long term depends strongly on the respective economic conditions and institutional characteristics.[27] From a practical point of view, much seems to depend on whether a clear employment goal of continuing education is discernible, although this is not the case in many unemployment cases.

A major limitation of active labour market policy measures is that they only start when unemployment occurs, i.e. when it is too late. However, there are several aspects that make **proactive action** before employment loss occurs difficult. First, government subsidies can easily crowd out company-funded continuing education activities and are primarily taken up by those groups of people who are already active in continuing education anyway. These findings are consistent for voucher programmes in Switzerland (Schwerdt et al. 2012), the United Kingdom (Abramovsky et al. 2011), and the Netherlands (Hidalgo et al. 2014), which have awarded vouchers for educational activities in the adult population. On average, voucher programmes were found to have no significant impact on income, employment, and subsequent education.[28] The findings suggest that people with a low educational level benefit most from continuing education, but use vouchers least frequently.[29] Accordingly, the findings cast doubt on the effectiveness of non-targeted government subsidies for continuing education. However, in the case of measures that directly target existing employers by providing training

incentives for employed workers, there is evidence of positive effects on career stabilisation and increased labour market retention, especially among older workers (McCall et al. 2016).

Second, in the current German training landscape, it is difficult for employees who see their jobs threatened by structural change and want to change careers to credibly signal to potential new employers that they have acquired the qualifications needed for the new occupational field. In contrast to a certificate of dual vocational training, for example, which sends a **clear signal** to all employers **about the skills acquired,** a certificate for a computer course or a digital training programme, for example, has little signal value for potential employers in the widely fragmented training market, because the content and checks are not clear. A key finding of modern information economics is that markets function inadequately when information about skills is only available asymmetrically on one side of the market and cannot be credibly communicated to the other side (e.g., Stiglitz 2000). A lack of framework conditions that enable the certification of acquired skills is one reason why there are insufficient training activities that are relevant for potential alternative employers.

IV.2.4. Establishment of a continuing education system based on the dual training system with certificates that send out a strong signal

In this respect, the measures taken to date, many of which are aimed at expanding existing offerings, fall short when it comes to the central issue of providing qualifications for a change of job across sectors.

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27 See Heckman et al. (1999), McCall et al. (2016), and Card et al. (2018) for detailed overview articles, and Lechner et al. (2011), Osikominu (2013), or Biewen et al. (2014) for selected German findings.

28 Similarly, Görlitz and Tamm (2016) find no income or employment effects of the German "education premium."

29 In general, employees whose jobs are particularly at risk from digital structural change due to a high proportion of routine activities are significantly less likely to participate in continuing education (Heß et al. 2019).

There is a lack of approaches to solutions that address an inadequacy of the system itself: **the insufficient possibility of certifying new skills acquired in continuing education** in combination with suitable structures for **identifying future employment opportunities and continuing education goals.**

One possibility would be to establish a **continuing education system based on the dual education system** with corresponding certificates. Such a genuine "system" for lifelong learning would first have to be established through the interaction of stakeholders – the state, employers' representatives and employees' representatives. It should also enable people at an older age (from around 35 years) to obtain a new signal education certificate (see Leopoldina 2021).[30] To achieve this, the dual education system would have to be adapted to the learning needs and potential of this age group. Those undergoing further training bring with them a great deal of practical experience that first-time trainees have yet to acquire. At the same time, learning behaviour is related to age. In this respect, further training courses could be shortened compared to initial training – to about one year – and should be modularised so that, for example, individual modules that individual trainees already bring with them from their initial training can be recognised.

In such a system, the **advantages of the dual training system could be transferred to continuing education.** As in the initial training system, the combination of school-based and in-company training would link theoretical and practical training content. In order for the retraining to take place, companies would have to offer a corresponding continuing education place for applicants who are new to the company. Involving the companies ensures that further training does not bypass the market.

Ultimately, neither individual companies nor government agencies know which occupational fields will require skilled labour in the future. The **best knowledge of the skill requirements** for sustainable employment opportunities will ultimately be revealed only through the **interplay of market forces.** Accordingly, the Board warns against approaches to continuing education in which policymakers attempt to plan continuing education needs to be promoted in detail at the level of occupational fields, as these do not take into account the decentrally distributed knowledge. Coordinated formats in which all stakeholders contribute their respective perspectives on market and employment opportunities appear to be more effective, in order to develop a joint transformation strategy at the level of local labour markets, for example, with corresponding impulses for continuing education.

The final examinations of such a continuing education system would be conducted by the relevant professional chambers, as in the dual training system. This ensures a standardisation of the skills learned that is comparable and **verifiable** across companies. As with the regulations for initial training, the content of further training in recognised further training occupations should be regulated in corresponding further training regulations, which, as in the dual training system, involve the trade associations, employers' organisations, trade unions, the Federal Institute for Vocational Education and Training, the federal states and the competent Federal Ministry.

Since those undergoing further training are likely to tend to have low regional mobility, coordination and school-based offerings should be strongly adapted to the respective **regional situation of structural change,** especially in a start-up phase.

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30   Consistent with the need for retraining in mid-life, it has been shown, especially for the dual vocational education and training that is widespread in German-speaking countries, that the advantages of an occupation-specific orientation in the transition from school to the labour market turn into disadvantages in employability in a changing world of work over the course of a person's working life (Hanushek et al. 2017).

In this way, continuing education that affects labour supply can be coordinated with regional and structural policy initiatives that affect the regional labour demand side.

As in the dual training system, **training partici-pants, companies and the state would each assume part of the (financing) burden.** Those undergoing further training would have to be satisfied with a low training salary for the retraining phase; the receiving companies would release the trainees on a daily basis for the school-based part of the further training and invest in the company-based part of the further training; and the state would take over the financing and implementation of the school-based part of the retraining. In cases where the losing companies continue to exist (but cut jobs in certain skill areas), these could also be included in the overall financing concept – analogous to the existing model of transfer companies.

Depending on the situation, it could be considered that the state takes over part of the financial burdens of employees and employers by providing appropriate **income compensation as part of a financial bridge** during the changeover. This may be justified, especially since the treasury benefits financially in the medium term from corresponding gains in tax revenues and social security contributions and savings in social spending as workers affected by structural change find new skilled employment (Hanushek et al. 2019). A **round table** of social partners, policymakers, training providers and academics should be convened to flesh out the elements of such a training system.

Compared to the current rather fragmented continuing education market, such an orderly system of continuing education would bring the advantages of **familiarity, simplicity, generality, transparency, quality assurance, information-rich qualifications and recognition of partial qualifications.**

The reliable signals for employers about the acquired competencies would make it worthwhile for employees who are threatened with job loss due to structural change to invest in these retraining courses. Through such dual retraining programmes in continuing education, they could acquire new signal training certificates tailored to market demand, enabling them to move into more future-proof employment. At the same time, this would provide a new opportunity for companies facing a major shortage of skilled workers to overcome it.

For reasons of general awareness and acceptance on both sides of the market, such a dual continuing education system should be implemented across the board as soon as possible. Nevertheless, **regional transformation networks,** such as those currently being promoted in the automotive industry, and decentralised continuing education networks, the establishment of which is currently being promoted among SMEs in particular, could be used as initial steps in this direction. Within the framework of these initiatives, regional departures and regional shortages of skilled workers could be measured in order to map retraining needs and opportunities. On this basis, regionally and sector-specifically coordinated offers of dual further training measures could be launched, in which the relevant players of employer and employee representatives as well as the state are appropriately involved. The experience gained could then be incorporated into a nationwide, cross-industry dual training system and interlinked with regional and structural policy initiatives such as the new German funding system for structurally weak regions to ensure the best possible interplay between supply-side and demand-side support instruments on the labour market.

IV.3 Inequality and the promotion of "good jobs"

There is much to suggest that technological progress, for example in the field of artificial intelligence, will exacerbate existing income inequality (see section III.5.). According to some authors, this could justify economic policy interventions to promote **employment, wages and productivity in the middle-income segment** (Rodrik and Stantcheva 2021 a,b,c). Moreover, this literature discusses policy instruments that do not satisfy the principle of preserving efficiency in production (Diamond and Mirrless 1971). Instead, policies alter firms' demand for labour and capital. Policy thus pre-distributes, and does not merely re-distribute, market incomes to correct the distribution of disposable incomes.

In the view of the Board, this new literature should be taken seriously and its further development closely monitored in the context of the digital transformation. However, it is **not yet suitable for the direct derivation of specific policy recommendations.**

- The discussed **robot taxes** are controversial conceptually and with regard to their practical feasibility. It is unclear whether this new form of taxation can be sensibly implemented in small open economies without leading to massive erosion of the tax base with long-term negative effects on the country's technological development. In addition, many questions are currently unanswered with regard to a possible concrete design. Even the object of taxation is unclear. Does the robot tax generally apply to the use of physical capital or only to certain categories? How should the exact delimitation be operationalised? How do robot taxes relate to the current form of corporate taxation, which is based on profits? Should it be introduced in addition? Is an imputation system envisaged?

- To be sure, an economic policy goal of **steering technological progress** may seem conceptually reasonable so that AI takes on a more job-creating and less job-saving character (Acemoglu 2021). However, it is unclear to the Board how the steering goal should be identified and defined, and through which instruments it could be implemented effectively. More clearly elaborated concepts, ideally already tested in practice, would be desirable. A more concrete proposal by Acemoglu (2021) concerns the currently **uneven tax burden on labour** compared to capital and software. This, he argues, leads to a bias in factor input decisions and contributes to the direction of investment decisions that favour labour-saving AI. The Board generally agrees with this analysis. However, an implementable proposal on how to address this is not yet available.

- The **policy matrix** proposed by Rodrik and Stantcheva (2021 a,b,c) to **promote a "good jobs economy"** also appears plausible and conceptually sensible. However, with regard to their specific policy proposals (education policy, continuing vocational training, strengthening co-determination in companies, regional and structural policy, etc.), it must be noted that they have already been implemented in large parts (at least in Germany) for many years.

V. Summary of recommendations for policymakers

The digital transformation is in full swing. It will have a significant impact on the German labour market in the coming years. In many areas, technological progress will improve welfare and make work easier. In some areas, however, it will displace jobs. In the view of the Board, however, there is no reason to worry **about technologically induced mass unemployment.** The only arguments against this are the **demographic developments** taking place at the same time and the general recognition that technological change does not merely replace human labour, but has always led to a change in existing employment opportunities and to the creation of new ones. In addition, Germany has an institutional structure that has helped it to cope with major structural disruptions in the labour market in the past.

However, the Board identifies **two central problem areas** that could arise on the German labour market in the course of the digital transformation: a) skills and regional mismatch, and b) rising wage and income inequality. Economic policy would be well advised to proactively address these challenges and set the appropriate course. To this end, the Board develops economic policy strategies in this report and arrives at the following key recommendations:

1) Digital catch-up

- Positive wage and employment effects of new digital technologies are more likely in Germany the stronger the domestic companies are positioned in the production and application of these technologies. In the field of artificial intelligence (AI), however, there are considerable deficits and a need for action, especially in the classic "data-hungry" forms of AI. For this, the **cooperative use of large amounts of data** across company boundaries must be enabled.

- In addition, for Germany's digital catch-up process, there is a need to strengthen **technology transfer institutions** and press ahead with **support for entrepreneurship** at universities as well as the **digitalisation of public administration.**

- **Venture capita**l must **be supported by the state** to the extent necessary to advance the transition from pilot developments to marketable systems in AI and other new digital technologies.

- In new forms of AI based on close **human-machine interaction,** German companies have a good starting position. In order to leverage this value creation potential, research, business and public institutions should work closely together to establish **"learning regulation"** through dialogue. This includes new types of contractual and labour law aspects arising in the course of this digital transformation.

2) An integrated system of education and training

A key economic policy response will have to be a comprehensive strategy of **continuing vocational training.** This includes not only on-the-job training, but also retraining for a change of occupation across industry boundaries, which will be increasingly necessary in the future to reduce mismatch.

- In the view of the Board, a promising option for retraining, particularly in the area of the heavily affected skilled workers in the middle qualification segment, could be to establish a continuing education system **based on the dual training system.** In such a genuine "system" for lifelong learning, the **advantages of the dual training system could be transferred to continuing education.** It should enable people to obtain new and signal educational certificates even at an older age.

- As in the dual training system, **participants, companies and the state would each assume part of the (financing) burden.** The organisation of the final examinations would be carried out by the relevant professional chambers. This ensures **standardisation** of the skills learned that is comparable and **verifiable** across companies. For reasons of general awareness and acceptance, such a dual continuing education system should be implemented **nationwide** as soon as possible.
- Within the system, **regional labour market differences** should be systematically recorded in order to map retraining needs and opportunities accordingly. In this way, regional transformation networks can dovetail labour supply-side continuing education activities with demand-side regional and structural policy initiatives.

- In order to flesh out the elements of such a continuing education system, the Board suggests convening a **round table** of social partners, policymakers, continuing education providers and academics in the near future.
- In order to promote comprehensive in-company continuing education, the Board suggests simplifying the sometimes confusing funding system and examining the possibility of establishing a legal right to continuing education.

Berlin, 23 February 2022

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und Wirtschaftsrecht
an der Universität Tübingen

Professor Dr. Axel Ockenfels
Professor für Wirtschaftliche Staatswissenschaften
Staatswissenschaftliches Seminar
an der Universität zu Köln

Professor Dr. Albrecht Ritschl
Professor für Wirtschaftsgeschichte
an der London School of Economics

Professor Dr. Olaf Sievert
Präsident der Landeszentralbank in den Freistaaten
Sachsen und Thüringen, Leipzig i. R.,
Honorarprofessor Universität Saarbrücken

Professor Dr. Dr. h.c. Hans-Werner Sinn
Präsident des Ifo-Instituts München i.R.
Em. Professor für Nationalökonomie und
Finanzwissenschaft
an der Universität München

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Em. Professor für Volkswirtschaftslehre und
Politische Ökonomie
an der Universität Mannheim

Professor Achim Wambach, Ph. D.
Präsident des ZEW – Leibniz-Zentrums für
Europäische Wirtschaftsforschung Mannheim
Professor für Volkswirtschaftslehre
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Professor Dr. Carl Christian von Weizsäcker
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Professor Dr. Eberhard Wille
Em. Professor für Volkswirtschaftslehre und
Finanzwissenschaft
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Professor Dipl.-Ing. Dr. Christine Zulehner
Professorin für Volkswirtschaftslehre
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Vizepräsidentin der Deutschen Bundesbank
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Lehrstuhl für VWL, insb. Wirtschaftstheorie
an der Friedrich-Alexander-Universität
Erlangen-Nürnberg

Professor Dr. Monika Schnitzer
Professorin für Volkswirtschaftslehre
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Appendix: Reports by the Board of Academic Advisors since April 1948

Online auf der Website des Wissenschaftlichen Beirats (www.wissenschaftlicher-beirat.de) abrufbar:

https://www.bmwk.de/Navigation/DE/Ministerium/Beiraete/Veroeffentlichungen-Wissenschaftlicher-Beirat/veroeffentlichungen-wissenschaftlicher-beirat.html

Gutachten vom 10. Februar 2022
„Die Zukunft der Arbeit in der digitalen Transformation"

Gutachten vom 4. Mai 2021
„Vorschläge für eine Reform der gesetzlichen Rentenversicherung"

Gutachten vom 12. März 2021
„Digitalisierung in Deutschland – Lehren aus der Corona-Krise"

Gutachten vom 22. Februar 2021
„Ein CO_2-Grenzausgleich als Baustein eines Klimaclubs"

Gutachten vom 26. Juni 2020
„Öffentliche Infrastruktur in Deutschland: Probleme und Reformbedarf"

Brief an Bundesminister für Wirtschaft und Energie Peter Altmaier vom 24. April 2020
„Corona-Krise"

Brief an Bundesminister für Wirtschaft und Energie Peter Altmaier vom 17. September 2019
„Moderne Wirtschaftspolitik braucht Evaluierung"

Gutachten vom 28. Juni 2019
„Energiepreise und effiziente Klimapolitik"

Brief an Bundesminister für Wirtschaft und Energie Peter Altmaier vom 30. April 2019
„Eine marktorientierte Verkehrswende"

Brief an Bundesminister für Wirtschaft und Energie Peter Altmaier vom 8. Februar 2019
„Nationale Industriestrategie"

Gutachten vom 7. Februar 2019
„Wirtschaftspolitische Probleme der deutschen Leistungsbilanz"

Brief an Bundesminister für Wirtschaft und Energie Peter Altmaier vom 9. Januar 2019
„Bildungsgerechtigkeit als Kernelement der Sozialen Marktwirtschaft"

Brief an Bundesminister für Wirtschaft und Energie Peter Altmaier vom 27. November 2018
„Messung der Leistungsbilanzüberschüsse"

Gutachten vom 29. Juni 2018
„Soziale Wohnungspolitik"

Gutachten vom 27. April 2018
„Zur Notwendigkeit und Ausgestaltung von internationalen Investitionsförder- und -schutzverträgen (IFV)"

Brief an Bundesministerin für Wirtschaft und Energie Brigitte Zypries vom 21. Dezember 2017
„Europa"

Gutachten vom 15. September 2017
„Sharing Economy und Wirtschaftspolitik"

Brief an Bundesministerin für Wirtschaft und Energie Brigitte Zypries vom 28. April 2017
„Zur Neugestaltung der Wirtschaftsbeziehungen mit Großbritannien"

Gutachten vom 9. Februar 2017
„Zur Diskussion um Bargeld und die Null-Zins-Politik der Zentralbank"

Brief an Bundesminister für Wirtschaft und Energie
Sigmar Gabriel vom 25. November 2016
„Zu den Vorschlägen des Basler Ausschusses für Bankenaufsicht zur Behebung von Missständen bei den Eigenkapitalvorschriften für Banken"

Gutachten vom 24. November 2016
„Die essenzielle Rolle des CO_2-Preises für eine effektive Klimapolitik"

Gutachten vom 16. September 2016
„Nachhaltigkeit der sozialen Sicherung über 2030 hinaus"

Brief an Bundesminister für Wirtschaft und Energie
Sigmar Gabriel vom 16. Juni 2016
„Gesetzliche Rentenversicherung"

Brief an Bundesminister für Wirtschaft und Energie
Sigmar Gabriel vom 26. April 2016
„Zur Förderung von Elektroautos"

Gutachten vom 5. Februar 2016
„Mehr Transparenz in der Bildungspolitik"

Gutachten vom 25. Juni 2015
„Regionale Wirtschaftsförderung"

Gutachten vom 24. April 2015
„Potenziale nutzen – mehr Fachkräfte durch weniger Arbeitsmarkthemmnisse"

Gutachten vom 26. September 2014
„Engpassbasierte Nutzerfinanzierung und Infrastrukturinvestitionen in Netzsektoren"

Gutachten vom 20. September 2013
„Langfristige Steuerung der Versorgungssicherheit im Stromsektor"

Gutachten vom 20. September 2013
„Evaluierung wirtschaftspolitischer Fördermaßnahmen als Element einer evidenzbasierten Wirtschaftspolitik"

Gutachten vom 30. November 2012
„Altersarmut"

Brief an Bundesminister für Wirtschaft und Technologie Dr. Rösler vom 16. Oktober 2012
„Zur Stabilität des Europäischen Finanzsystems"

Brief an Bundesminister für Wirtschaft und Technologie Dr. Rösler vom 31. Juli 2012
„Mindestlohn"

Gutachten vom 2. Februar 2012
„Wege zu einer wirksamen Klimapolitik"

Gutachten vom 25. November 2011
„Realwirtschaftliche Weichenstellungen für einen stabilen Euro"

Brief an Bundesminister für Wirtschaft und Technologie Rainer Brüderle vom 2. Mai 2011
„Zur Novelle des Erneuerbare-Energien-Gesetzes"

Gutachten vom 27. November 2010
„Überschuldung und Staatsinsolvenz in der Europäischen Union"

Gutachten vom 16. April 2010
„Reform von Bankenregulierung und Bankenaufsicht nach der Finanzkrise"

Gutachten vom 16. April 2010
„Zur Reform der Finanzierung der Gesetzlichen Krankenversicherung"

Gutachten vom 6. November 2009
„Akzeptanz der Marktwirtschaft: Einkommens-verteilung, Chancengleichheit und die Rolle des Staates"

Brief an Bundesminister für Wirtschaft und Technologie Michael Glos vom 23. Januar 2009
„Zur Bankenregulierung in der Finanzkrise"

Brief an Bundesminister für Wirtschaft und Technologie Michael Glos vom 5. Dezember 2008
„Europäisches System des Handels von CO_2-Emissionen"

Brief an Bundesminister für Wirtschaft und Technologie Michael Glos vom 10. Oktober 2008
„Aktuelle Entwicklungen im Finanzsystem"

Brief an Bundesminister für Wirtschaft und Technologie Michael Glos vom 17. April 2008
„Kein Staatseingriff bei Mitarbeiterbeteiligungen"

Gutachten vom 24. Januar 2008
„Zur Begrenzung der Staatsverschuldung nach Art. 115 GG und zur Aufgabe des Stabilitäts- und Wachstumsgesetzes"

Brief an den Bundesminister für Wirtschaft und Technologie Michael Glos vom 9. Dezember 2007
„Schuldenbegrenzung nach Art. 115 GG"

Brief an den Bundesminister für Wirtschaft und Technologie Michael Glos vom 9. Juli 2007
„Gesetzentwurf Wagniskapitalbeteiligung (WKBG) und Unternehmensbeteiligungs-gesellschaften (UBGG)"

Gutachten vom 12. Mai 2007
„Öffentliches Beschaffungswesen"

Gutachten vom 24. März 2007
„Patentschutz und Innovation"

Brief an den Bundesminister für Wirtschaft und Technologie Michael Glos vom 20. Januar 2007
„Gesundheitsreformgesetz"

Brief an den Bundesminister für Wirtschaft und Technologie Michael Glos vom 20. November 2006
„Wettbewerbsverhältnisse und Preise der deutschen Energiewirtschaft"

Gutachten vom 16. September 2006
„Mehr Vertragsfreiheit, geringere Regulierungsdi-chte, weniger Bürokratie"

Gutachten vom 12./13. Mai 2006
„Mehr Wettbewerb im System der Gesetzlichen Krankenversicherung"

Brief an den Bundesminister für Wirtschaft und Technologie Michael Glos vom 18. März 2006
„Kombi- und Mindestlöhne"

Gutachten vom 21. Januar 2006
„Der deutsche Arbeitsmarkt in Zeiten globalisierter Märkte"

Gutachten vom 8. Juli 2005
„Zur finanziellen Stabilität des Deutschen Föderalstaates"

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„Alterung und Familienpolitik"

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„Keine Aufweichung der Pressefusionskontrolle"

Brief an den Bundesminister für Wirtschaft und Arbeit Wolfgang Clement vom 17. Januar 2004
„Ausbildungsplatzabgabe"

Gutachten vom 16. Januar 2004
„Zur Förderung erneuerbarer Energien"

Brief an den Bundesminister für Wirtschaft und Arbeit Wolfgang Clement vom 6. Dezember 2003
„Europäische Verfassung"

Gutachten vom 11. Oktober 2003
„Tarifautonomie auf dem Prüfstand"

Gutachten vom 15./16. November 2002
„Die Hartz-Reformen – ein Beitrag zur Lösung des Beschäftigungsproblems?"

Brief an den Bundesminister für Wirtschaft und Arbeit Wolfgang Clement vom 10./11. Oktober 2002
„Personal-Service-Agenturen"

Gutachten vom 28./29. Juni 2002
„Reform des Sozialstaats für mehr Beschäftigung im Bereich gering qualifizierter Arbeit"

Gutachten vom 12. Januar 2002
„Daseinsvorsorge im europäischen Binnenmarkt"

Gutachten vom 6. Juli 2001
„Wettbewerbspolitik für den Cyberspace"

Brief an den Bundesminister für Wirtschaft und Technologie Dr. Werner Müller vom 16. Dezember 2000
„Reform der gesetzlichen Rentenversicherung"

Gutachten vom 1. Juli 2000
„Reform der europäischen Kartellpolitik"

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„Aktuelle Formen des Korporatismus"

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„Offene Medienordnung"

Brief an den Bundesminister für Wirtschaft und Technologie Dr. Werner Müller vom 19./20. Februar 1999
„Wechselkurszielzonen"

Gutachten vom 18./19. Dezember 1998
„Neuordnung des Finanzierungssystems der Europäischen Gemeinschaft"

Gemeinsame Stellungnahme der Wissenschaftlichen Beiräte beim BMF und BMWi vom 02.10.1998
„Reform der Einkommen- und Körperschaftsteuer"

Gutachten vom 20./21. Februar 1998
„Grundlegende Reform der gesetzlichen Rentenversicherung"

Brief an Bundeswirtschaftsminister Dr. Rexrodt vom 11. Juni 1997
„Protokoll zu Art. 222 EG-Vertrag bezüglich der Einstandspflichten öffentlich-rechtlicher Körperschaften für ihre öffentlich-rechtlichen Kreditinstitute"

Brief an Bundeswirtschaftsminister Dr. Rexrodt vom 11. Juni 1997
„Ein Beschäftigungskapitel im Maastricht II-Vertrag?"

Gutachten vom 25./26. April 1997
„Wagniskapital"

Gutachten vom 9. November 1996
„Anstehende große Steuerreform"

Gutachten vom 30. August 1996
„Anpassung des deutschen Kartellgesetzes an das europäische Recht?"

Gutachten vom 19./20. Januar 1996
„Langzeitarbeitslosigkeit"

Gutachten vom 9. März 1995
„Orientierungen für eine Postreform III"

Brief an Bundeswirtschaftsminister Dr. Günter Rexrodt vom 23. Januar 1995
„Wirtschaftspolitische Folgerungen aus der Verfassungswidrigkeit des sogenannten Kohlepfennigs"

Gutachten vom 31. August 1994
„Ordnungspolitische Orientierung für die Europäische Union"

Gutachten vom 10./11. Juli 1992
„Gesamtwirtschaftliche Orientierung bei drohender finanzieller Überforderung"

Gutachten vom 24. Januar 1992
„Stellungnahme zu den Vorschriften über eine Industriepolitik in den Verträgen über die Europäische Politische Union und die Europäische Wirtschafts- und Währungsunion"

Gutachten vom 12. bis 14. Juli 1991
„Lohn- und Arbeitsmarktprobleme in den neuen Bundesländern"

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„Probleme der Privatisierung in den neuen Bundesländern"

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„Stellungnahme zu den GATT-Verhandlungen"

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„Aufzeichnung der Beratungsergebnisse zu den Belastungen durch die deutsche Einheit"

Gutachten vom 29./30. Juni 1990
„Außenwirtschaftspolitische Herausforderungen der Europäischen Gemeinschaft an der Schwelle zum Binnenmarkt"

Gutachten vom 1./2. März und 27. März 1990
„Schaffung eines gemeinsamen Wirtschafts- und Währungsgebietes in Deutschland"

Gutachten vom 17./18. November und 15./16. Dezember 1989
„Wirtschaftspolitische Herausforderungen der Bundesrepublik im Verhältnis zur DDR"

Gutachten vom 5. Juni 1989
„Stellungnahme zum Bericht des Delors-Ausschusses"

Gutachten vom 20./21. Januar 1989
„Europäische Währungsordnung"

Gutachten vom 26./27. Februar 1988
„Wirtschaftspolitische Konsequenzen aus den außenwirtschaftlichen Ungleichgewichten der großen Industrieländer"

Gutachten vom 26./27. Juni 1987
„Gewinn, Investitionen und Beschäftigung"

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„Wettbewerbspolitik"

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„Stellungnahme zum Weißbuch der EG-Kommission über den Binnenmarkt"

Gutachten vom 11. und 12. Oktober 1985
„Steuerpolitik unter gesamtwirtschaftlichen Gesichtspunkten"

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„Strukturwandel für Wachstum und mehr Beschäftigung"

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„Vermindert Arbeitszeitverkürzung die Arbeitslosigkeit?"

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„Konjunkturpolitik – neu betrachtet"

Gutachten vom 23. Januar 1982
„Probleme der Wohnungswirtschaft"

Gutachten vom 23. Februar 1981
„Wirtschaftspolitik bei defizitärer Leistungsbilanz"

Stellungnahme vom 17. Januar 1981
„Probleme der Stahlindustrie in der Europäischen Gemeinschaft"

Gutachten vom 9. Februar 1980
„Wirtschaftspolitische Implikationen eines Bevölkerungsrückgangs"

Gutachten vom 7. und 8. Dezember 1979
„Wirtschaftspolitische Folgerungen aus der Ölverknappung"

Gutachten vom 15. und 16. Dezember 1978
„Staatliche Interventionen in einer Marktwirtschaft"

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„Aktuelle Probleme der Beschäftigungspolitik"

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„Rationalisierungsinvestitionen"

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„Fragen einer neuen Weltwirtschaftsordnung"

Gutachten vom 14. und 15. November 1975
„Kosten und Preise öffentlicher Unternehmen"

Gutachten vom 9. und 10. Mai 1975
„Indexierung wirtschaftlich relevanter Größen"

Gutachten vom 15. und 16. März 1974
„Probleme der Ausländerbeschäftigung"

Gutachten vom 16. und 17. November 1973
„Höchstpreisvorschriften für Energie"

Gutachten vom 19. und 20. Oktober 1973
„Stabilitätspolitische Problematik der gesetzlichen Rentenversicherung"

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„Grundfragen der Stabilitätspolitik"

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„Regelmechanismen und regelgebundenes Verhalten in der Wirtschaftspolitik"

Stellungnahme vom 3. Juli 1971 zum
„gegenwärtig bestehenden Problem der Wechselkurspolitik"

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„Entwicklung der Wohnungsmieten und geplante Maßnahmen zur Begrenzung des Mietanstiegs"

Gutachten vom 24. Oktober 1970
„Problematik der gegenwärtigen hohen Zinssätze"

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„Einführung einer Fusionskontrolle"

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„Aktuelle Probleme der außenwirtschaftlichen Absicherung"

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„Fragen der Staatsverschuldung"

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„Zusammenhang zwischen außenwirtschaftlichem Gleichgewicht und Preisniveaustabilität"

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**„Gesetzentwurf zur Anpassung und Gesundung
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Gutachten vom 28. Februar 1967
„Subventionen in der Marktwirtschaft"

Gutachten vom 18. Juni 1966
„Staatliche Zinsregulierungen"

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„Ständige Preiserhöhungen in unserer Zeit"

Gutachten vom 31. Oktober 1964
**„Zusammenwirken staatlicher und nichtstaatli-
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**„Zusammenwirken von staatlichen und nicht-
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„Wirtschaftliche Vorausschau auf mittlere Sicht"

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**„Selbstfinanzierung bei verlangsamtem
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Gutachten vom 23. Juni 1962
**„Reform des Gesetzes gegen Wettbewerbs-
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Stellungnahme vom 4. März 1961 zur
„Aufwertung der D-Mark"

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**„Gedanken über die Konzeption einer künftigen
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**„Gegenwärtige Möglichkeiten und Grenzen einer
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Gutachten vom 25. Januar 1960
**„Probleme einer rationellen Wirtschaftshilfe an
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Gutachten vom 14. April 1959
**„Konjunkturpolitische Situation der Bundes-
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Stellungnahme vom 3. März 1959 zur
**„internationalen Koordinierung der Konjunktur-
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Gutachten vom 27. Juli 1958
**„Problem Verteidigungslast und volkswirtschaft-
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Gemeinsames Gutachten des Wissenschaftlichen
Beirats beim Bundesminister der Finanzen und des
Wissenschaftlichen Beirats beim Bunde-
swirtschaftsministerium vom 26. Januar 1958
„Kapitalmarkt und Besteuerung"

Gutachten vom 30. April 1957
**„Wirtschaftspolitische Problematik der deutschen
Exportüberschüsse"**

Gutachten vom 24. Februar 1957
„Problem von Index- und Preisgleitklauseln"

Gutachten vom 3. Juni 1956 und 7. August 1956
**„Instrumente der Konjunkturpolitik und ihre
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Gutachten vom 11. Oktober 1955
„Welche Maßnahmen entsprechen der gegenwärtigen konjunkturellen Situation?"

Gutachten vom 12. Juni 1955
„Probleme einer produktivitätsorientierten Lohnpolitik"

Gutachten vom 23. Januar 1955
„Möglichkeiten und Grenzen regionaler Wirtschaftspolitik"

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„Einführung von direkten Tarifen"

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„Anträge und Gesetzentwürfe zur Beschränkung des Wettbewerbs in gewissen Gewerben und Berufen"

Gutachten vom 23. Oktober 1954
„Probleme der volkswirtschaftlichen Gesamtrechnung und ihrer Auswertung"

Gutachten vom 2. Oktober 1954
„Fragen des Kartellproblems, die durch die bevorstehende Gesetzgebung aufgeworfen werden"

Gutachten vom 31. Mai 1954
„Problem landwirtschaftlicher Paritätspolitik im Rahmen der allgemeinen Wirtschaftspolitik"

Gutachten vom 10. Januar 1954
„Sicherung der wirtschaftlichen Expansion"

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„Fragen des gemeinsamen Marktes"

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„Problem der gegenwärtigen deutschen Zahlungsbilanz"

Gutachten vom 1. Mai 1953
„Frage der wirtschaftlichen Integration Europas"

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„Problem der Integration der europäischen Agrarmärkte (sogenannte Agrarunion)"

Ergebnis der Beratungen vom 17./18. Januar 1953
„Sicherung der wirtschaftlichen Expansion"

Gutachten vom 14. Dezember 1952
„Frage des gemeinsamen Marktes innerhalb der Europäischen Gemeinschaft für Kohle und Stahl"

Gutachten vom 16. November 1952
„Konvertierbarkeit der Währungen"

Gutachten vom 6. Juli 1952
„Wiederaufbau des Kapitalmarktes und Zinspolitik"

Gutachten vom 8. Juni 1952
„Verteidigungsleistungen und Wirtschaftsverfassung"

Gutachten vom 27. April 1952
„Ausgleich der Währungsspannen im Rahmen einer europäischen Integration"

Gutachten vom 4. Februar 1952
„Belebung des Wertpapiermarktes"

Gutachten vom 9. Oktober 1951
„Ist zur Überwindung der gegenwärtigen Aufschwunghemmung eine aktive Konjunkturpolitik anzuraten?"

Gutachten vom 29. Juli 1951
„Außenhandelspolitik"

Gutachten vom 10. Juni 1951
„Lenkungsmaßnahmen"

Stellungnahme vom 29. April 1951
„Investitionshilfe"

Vorläufige Stellungnahme vom 25. Februar 1951
**„Wirtschaftspolitische Möglichkeiten zur
Begrenzung der direkten lenkenden Eingriffe"**

Gutachten vom 28. Januar 1951
„Bereinigung des Preisgefüges"

Gutachten vom 10. Dezember 1950
„Kapitalmarktpolitik und Investitionspolitik"

Vorläufige Stellungnahme vom 5. November 1950
**„Deckung des zusätzlichen künftigen Finanz-
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Gutachten vom 5. November 1950
**„Einwirkung der Weltkonjunktur auf die deutsche
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Gutachten vom 24. September 1950
**„Struktur- und konjunkturpolitische Fragen
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**„Probleme der Kapitalbildung und der Geld-
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**„Stellung des Wohnungswesens in der sozialen
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**„Kapitalmangel und Arbeitslosigkeit in der
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„Europäische Zahlungsunion"

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**„Das Dollardefizit Europas im Handel mit USA
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Gutachten vom 30. Oktober 1949
„Agrarpolitik in der sozialen Marktwirtschaft"

Gutachten vom 18. September 1949
„Geldordnung und Wirtschaftsordnung"

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„Grundsatzfragen der Monopolgesetzgebung"

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„Expansive und kontraktive Kreditpolitik"

Gutachten vom 27. Februar 1949
„Investitionsmittel und ERP-Mittel"

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„Preispolitik und Außenhandelsgestaltung"

Gutachten vom 24. Oktober 1948
„Agrarpolitik und Agrarpreise"

Gutachten vom 3. September 1948
**„Währungs-, Preis-, Produktions- und Investitions-
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„Investitionspolitik nach der Währungsreform"

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Bewirtschaftung und der Preispolitik nach
der Währungsreform"**

Die Wurzeln des Wissenschaftlichen Beirats beim Bundesministerium für Wirtschaft und Klimaschutz reichen zurück bis in die Zeit des Zweiten Weltkrieges. Ab 1943 trafen sich einige der späteren Beiratsmitglieder unter dem Vorsitz von Prof. Erwin von Beckerath, um die wirtschaftliche Zukunft Deutschlands nach dem Krieg vorzubereiten. Diese so genannte „Arbeitsgemeinschaft Erwin von Beckerath" ging in dem Anfang 1948 gegründeten Beirat auf, der am 23. Januar 1948 auf Einladung der Verwaltung für Wirtschaft des Vereinigten Wirtschaftsgebietes, dem Vorläufer des Bundesministeriums für Wirtschaft und Klimaschutz, in Königstein/Taunus formell konstituiert wurde.

Der Beirat hatte folgende 17 Gründungsmitglieder:

Prof. Dr. Franz Böhm,

Prof. Dr. Walter Eucken,

Prof. Dr. Walther G. Hoffmann,

Prof. Dr. Wilhelm Kromphardt,

Prof. Dr. Adolf Lampe,

Prof. Dr. Elisabeth Liefmann-Keil,

Prof. Dr. Alfred Müller-Armack,

Prof. Dr. Oswald v. Nell-Breuning,

Prof. Dr. Erik Nölting,

Prof. Dr. Hans Peter,

Prof. Dr. Erich Preiser,

Prof. Dr. Ludwig Raiser,

Prof. Dr. Heinz Sauermann,

Prof. Dr. Karl Schiller,

Prof. Dr. Otto Veit,

Prof. Dr. Gerhard Weisser,

Prof. Dr. Theodor Wessels.

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